WATER QUALITY ASSESSMENT OF THE RED RIVER AND LAKE WINNIPEG FOLLOWING RELEASE OF RAW SEWAGE FROM THE CITY OF WINNIPEG, SEPTEMBER 2002

Nicole Armstrong and Dwight Williamson
Water Quality Management Section,
Water Branch

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SUMMARY

Following a valve failure at the North Winnipeg Pollution Control Centre on September 16, 2002, untreated sewage overflowed to the Red River for a period of 60 hours at a rate of 2.14 m^3/s. During this period of time, a total of 462,500 cubic metres of untreated sewage entered the Red River from a number of combined sewer outfall locations within the City of Winnipeg. While initial travel time estimates suggested that the plume of untreated sewage would reach Lake Winnipeg after about 8 to 10 days, higher flows on the Red River reduced travel times to about three to four days. Bacterial densities indicated that untreated sewage reached Lake Winnipeg on September 20, 2002. While *E. coli* densities within the sewage plumes were greater than 800,000/100 mL, densities within the fully mixed river peaked at about 72,000/100 mL near Bannatyne Street within the City of Winnipeg. Peak *E. coli* densities declined with distance downstream, rising to 57,000 near Rivercrest, 10,000 near Lockport, 2,700 at Selkirk, and 290/100 mL near Lake Winnipeg. While very low dissolved oxygen concentrations (< 1 mg/L) were observed within the sewage plumes, dissolved oxygen concentrations declined to only about 5.1 mg/L with the fully mixed river near Rivercrest, approximately 58 km from Lake Winnipeg. Therefore, dissolved oxygen concentrations within the fully mixed river remained within Manitoba's Water Quality Standards, Objectives, and Guidelines. Bacterial densities at beaches on the east and west sides of Lake Winnipeg were not impacted by the sewage release. Comparison of samples collected 18 days prior to the sewage release and those collected several days after indicated that the macroinvertebrate bottom-dwelling community was not impacted at Selkirk as a result of the spill. While differences were observed between macroinvertebrate densities on the west and east banks of the Red River, it is unknown if the differences can be attributed to the raw sewage overflow event near the west bank or to normal variability due to within-stream substrate preferences.

SOMMAIRE

Par suite de la défaillance d'une vanne survenue au centre de lutte contre la pollution de North Winnipeg, le 16 septembre 2002, des eaux usées non traitées ont débordé dans la rivière Rouge pendant une période de 60 heures à un débit de 2,14 m^3/sec. Au cours de cette période, un total de 462 500 m^3 d'eaux usées non traitées se sont déversés dans la rivière Rouge à partir de plusieurs points de rejet de la ville de Winnipeg. Même si les estimations du temps de parcours initial suggéraient que le panache d'eaux usées non traitées atteindrait le lac Winnipeg après 8 à 10 jours, l'accélération du débit de la rivière Rouge a réduit le temps de parcours à 3 ou 4 jours. Les densités bactériennes ont démontré que les eaux usées non traitées ont atteint le lac Winnipeg le 20 septembre 2002. Même si les densités d'*E. coli* dans les panaches d'eaux usées dépassaient le taux de 800 000/100 ml, les densités une fois les eaux usées mélangées complètement à la rivière ont plafonné à environ 72 000/100 ml à proximité de la rue Bannatyne, dans la ville de Winnipeg. Les densités maximum d'*E. coli* ont baissé avec la distance en aval, atteignant 57 000 près de Rivercrest, 10 000 aux environs de Lockport, 2 700 à Selkirk, et 290/100 ml à proximité du lac Winnipeg. Même si des concentrations très basses d'oxygène dissous (< 1 mg/l) ont été observées dans les panaches d'eaux usées, les concentrations d'oxygène dissous ont diminué jusqu'à environ 5,1 mg/l une fois les eaux usées complètement mélangées à la rivière, vers Rivercrest, à environ 58 km du lac Winnipeg. Par conséquent, les concentrations d'oxygène dissous une fois les eaux usées mélangées complètement à la rivière sont demeurées en deçà des normes, objectifs et directives du Manitoba en matière de qualité de l'eau. Les densités bactériennes relevées sur les plages des rives est et ouest du lac Winnipeg n'ont pas été touchées par le déversement d'eaux usées. Le rapprochement d'échantillons recueillis 18 jours avant le déversement d'eaux usées et de ceux recueillis plusieurs jours après a démontré que la population macro-invertébrée de fond n'avait pas été affectée à Selkirk par les conséquences du déversement. Bien que des écarts aient été observés entre les densités de macro-invertébrés sur les rives ouest et est de la rivière Rouge, on ne sait pas si les écarts peuvent être attribués au déversement d'eaux usées à proximité de la rive ouest ou aux variations normales découlant des préférences en matière de substrat dans le cours d'eau.

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ACKNOWLEDGEMENTS

During the week of, and much of the two weeks following the City of Winnipeg's North End Water Pollution Control Centre sewage release, water and invertebrate samples were collected on the Red River by Dave Green, Alexandra Bourne, Rollie Fortin, and Colin Hughes. Wendy Ralley collected water samples from Lake Winnipeg beaches during and after the sewage release. Their assistance is gratefully acknowledged.

BACKGROUND

- The City of Winnipeg's North End Water Pollution Control Centre, located at 2230 Main Street, provides wastewater treatment to sewage generated from the north and central parts of the city. This facility serves approximately 370,000 residents and treats about 70 % of the sewage generated by the city.
- At 1:30 PM on Monday, September 16, 2002, City of Winnipeg maintenance workers were removing an inspection hatch on one of six pumps when an apparent valve failure caused the uncontrolled release of sewage into the pump room.
- As a result of the pump room damage, all sewage that would normally enter the plant for treatment began to overflow through a number of combined sewer outfalls directly into the Red River. Untreated sewage began to overflow to the river around 5:00 PM on September 16, 2002.
- Two pump motors were repaired and returned to service by 2:00 AM, September 19, 2002. By 5:00 AM, September 19, 2002, overflow to the river had stopped and the treatment plant was in full operation.
- Consequently, untreated sewage overflowed to the Red River for a period of 60 hours at a rate of 185,000 cubic metres per day (or 2.141 cubic metres per second). During this period of time, a total of 462,500 cubic metres of untreated sewage entered the Red River from a number of combined sewer outfall locations within the City of Winnipeg.
- Water flows in the Red River (at James Avenue in the City of Winnipeg) during this period of time ranged from approximately 184.9 cubic metres per second on September 16, 2002 to about 154.0 cubic metres per second on September 19, 2002. Thus, untreated sewage comprised approximately 1.2 % of the fully mixed river flow on Monday, September 16, 2002 and about 1.4 % by Thursday, September 19, 2002.
- Manitoba Conservation collected water samples daily on the Red River between Tuesday, September 17, 2002 and Monday, September 23, 2002 to determine the effects of the sewage release on water quality.
- Fourteen stations were sampled on the Red River between the Provencher Street Bridge and Lake Winnipeg (Table 1, and Figures 1 and 2). Samples were analysed for dissolved oxygen, ammonia, fecal coliforms and *Escherichia coli* (*E. coli*), biochemical oxygen demand, pH, conductivity, total dissolved solids, total suspended solids, turbidity, nitrate-nitrite, total kjeldahl nitrogen, total phosphorus, organic phosphorus, and inorganic phosphorus (see Tables 2 to 20). Additional samples were collected on September 20, 2002 and analysed for 40 trace metals (Table 21). Additional measurements of dissolved oxygen, temperature, and conductivity were made in the field (Tables 22 to 24).
- Field measurements of dissolved oxygen and conductivity were made within the effluent outfall plumes (Table 25).

- Additional water samples were collected at the Bannatyne Street combined sewer overflow outfall and at the North End Water Pollution Control Centre outfall and were analyzed for fecal coliform and *E. coli* densities.

- Water quality sampling was followed by collections of bottom-dwelling aquatic invertebrates at five locations between Provencher Bridge and Lake Winnipeg.

- Bacterial densities were monitored twice per week at major Lake Winnipeg beaches until the end of September 2002.

- Initially, travel time for the plume of untreated sewage to reach Lake Winnipeg was estimated to be 8 to 10 days. However, higher flows on the Red River likely reduced travel times to about 3 to 4 days. Bacteria data indicated that the untreated sewage reached Lockport on September 18, 2002, Selkirk on September 19, 2002, and 3 km upstream of Lake Winnipeg on September 20, 2002.

September 17, 2002

- Fecal coliform and *E. coli* data (Figure 3) indicated that the discharge had reached Rivercrest, between the North Perimeter and Lockport. Bacteria densities increased fairly substantially from a background of less than 1,000/100 mL to about 40,000/100 mL. It was predicted through initial water quality modelling that densities of around 30,000/100 mL could be expected. The observed densities were slightly higher than expected, but within the same general range.
- The province maintains its recommendation that the river should not be used for recreation purposes such as swimming or for personal use such as consumption and irrigation for ready-to-eat garden produce. Proper handling procedures for angling and processing fish from the river should still be observed.
- Dissolved oxygen concentrations (Figure 4) within the fully mixed regions of the river were all 6.0 mg/L or greater and were therefore well within Manitoba's Water Quality Standards, Objectives, and Guidelines. There was no appreciable decline in dissolved oxygen during the first day.
- Dissolved oxygen concentrations in the middle of some of the effluent plumes (within 1.5 metres of the outfall) were 1.0 mg/L or less. The discharges mixed relatively rapidly with the Red River such that within about 15 metres, dissolved oxygen concentrations had returned to the 6.0 mg/L range.
- Ammonia concentrations (Figure 5) were well within the Manitoba Water Quality Standards, Objectives, and Guidelines and should not have posed a problem for aquatic life.

September 18, 2002

- Fecal coliform and *E. coli* data (Figure 3) indicated that the discharge had reached Lockport. Bacteria densities increased fairly substantially from a background of less than 1,000/100 mL to about 50,000/100 mL between the North Perimeter and Rivercrest. Densities then declined to about 8,000/100 mL towards Lockport before returning to background densities at Selkirk. As expected, bacteria densities within outfall plumes were high (Jefferson Avenue outfall plume bacterial densities were about 750,000/100 mL).
- Minimum dissolved oxygen concentrations (Figure 4) were observed in the Rivercrest area, located between the North Perimeter and Lockport. Concentrations declined from 7.0 to 8.0 mg/L within the City of Winnipeg to about 5.9 mg/L in the Rivercrest area and then increased to normal background towards Lockport. An additional increase occurred as the water became aerated at the Lockport Dam. The minimum oxygen level of 5.9 mg/L is within the Manitoba Water Quality Standards, Objectives, and Guidelines.

September 19, 2002

- Fecal coliform and *E. coli* data (Figure 3) indicated that the discharge had reached Selkirk. Fecal coliform densities increased fairly substantially from a background of less than 1,500/100 mL to peak at about 100,000/100 mL between the North Perimeter and Rivercrest. Densities then declined to about 14,000/100 mL towards Lockport and continued to decline towards Selkirk. Densities at Selkirk were about 4 times mean September densities (1990s) at about 2,200/100 mL but returned to background levels within 3 km of Lake Winnipeg (50/100 mL). *Escherichia coli* densities followed the same general trend with peak densities at Rivercrest and a return to background levels just upstream of Lake Winnipeg.
- Minimum dissolved oxygen concentrations (Figure 4) were again observed in the Rivercrest area, located between the North Perimeter and Lockport. Concentrations declined from between 5.7 and 7.0 mg/L within the City of Winnipeg to about 5.1 mg/L in the Rivercrest area and then increased to normal background towards Lockport. An additional increase occurred as the water became aerated at the Lockport Dam. The minimum oxygen level of 5.1 mg/L is within the Manitoba Water Quality Standards, Objectives, and Guidelines.
- Dissolved oxygen concentration near the effluent outfalls had returned to a background level of about 7 mg/L (Table 25).

September 20, 2002

- The peak in fecal coliform and *E. coli* densities shifted downstream to the area between Twin Oaks and Lockport, and increased from a background of less than 500/100 mL within the City of Winnipeg to greater than 7,300/100 mL.
- *Escherichia coli* and fecal coliform densities within 3 km of Lake Winnipeg increased and peaked at slightly above those observed during previous days (about 300/100 mL) suggesting that the discharge had reached Lake Winnipeg. Bacterial die off within the about 76 km between the first combined sewer outfall and Lake Winnipeg reduced bacterial densities from over 100,000 to less than 500/100 mL.
- The minimum dissolved oxygen concentration (Figure 4) increased from the previous day to 6.5 mg/L, and also occurred further downstream at the upstream side of Lockport Dam (6.5 mg/L).
- Measurements of dissolved oxygen near the effluent outfalls were again near background concentrations of about 7 mg/L (Table 25).

September 21, 2002

- The peak in fecal coliform densities was again observed at the area between Twin Oaks and Lockport and increased from a background of less than 500/100 mL within the City of Winnipeg to about 4,000/100 mL. *Escherichia coli* densities were between 700 and

4,000/100 mL between the City of Winnipeg and Selkirk with the highest densities occurring within the City of Winnipeg. *Escherichia coli* and fecal coliform densities within 3 km from Lake Winnipeg returned to background levels of less than 50/100 mL.

- Dissolved oxygen concentrations were near background at all sites on the Red River (above 6.8 mg/L).

September 22, 2002

- *Escherichia coli* densities were less than 2,100/100 mL across the entire sampling reach, and returned to normal background levels at Selkirk and near Lake Winnipeg. Fecal coliform densities were slightly higher but less than 3,600/100 mL across the entire sampling reach and were at normal background levels at Selkirk and near Lake Winnipeg. The highest densities of *E. coli* and fecal coliforms were found within the City of Winnipeg.
- Dissolved oxygen concentrations were reduced at several stations on the Red River within the City of Winnipeg, including the most upstream station at the Provencher Bridge, and further downstream near Rivercrest and Twin Oaks. Reduced dissolved oxygen concentrations at many stations, including upstream of the combined sewer outfalls, suggests that a separate event was influencing dissolved oxygen concentrations in the Red River on September 22, 2002.

September 23, 2002

- Bacterial densities returned to background levels at all stations on the Red River both within and downstream of the City of Winnipeg (less than 1,700/100 mL).
- Dissolved oxygen trends observed on September 23, 2002 continued with concentrations further reduced at several stations within the City of Winnipeg including the most upstream station at the Provencher Bridge, and further downstream near Rivercrest and Twin Oaks. Reduced dissolved oxygen concentrations at many stations, including upstream of the combined sewer outfalls, suggests that a separate event was influencing dissolved oxygen concentrations in the Red River on September 23, 2002.

RED RIVER AQUATIC INVERTEBRATES

- On September 24 and 25, 2002, the bottom-dwelling macroinvertebrate community in the Red River was sampled to assist in determining whether impacts to the biological community may have occurred due to raw sewage overflow.
- The community was sampled with a standard Ponar dredge (0.0523 m^2). Samples were collected in triplicate within the areas affected by outfall plumes near Jefferson Avenue (RR8) and Kildonan Park (RR14) adjacent to the west bank of the river. Control or background reference samples in triplicate were collected from adjacent near-shore areas on the opposite east bank. The macroinvertebrate community was also sampled near Selkirk (RR12) and from the site located immediately upstream of Lake Winnipeg (RR13). Five replicates were collected in a transect across the river at these two latter locations.
- As part of the Water Quality Management Section's routine biological monitoring program, the macroinvertebrate community at the Selkirk site had been sampled 18 days prior to the raw sewage overflow event. These data provided a valuable assessment of the macroinvertebrate community at the Selkirk location prior to the City of Winnipeg's sewage overflow event.
- Data (Table 28) were converted to densities per m^2, transformed to base 10 logarithms to stabilize variances (after adding 0.0001 to all values to allow transformation of zero values), then analyzed by one way analysis of variance. Probabilities of differences are shown in Table 27.
- There were no statistically significant differences between samples collected from the Selkirk site (OJS074) 18 days prior to the sewage overflow event and samples collected from the same site several days following the event. This indicates that the macroinvertebrate bottom-dwelling community was not impacted at Selkirk as a result of the spill (Table 27; Figure 6).
- Samples collected from near-shore zones immediately adjacent to two combined sewer overflow discharges near the west bank (Jefferson Avenue and Kildonan Park) were statistically significantly different than reference samples collected from similar areas near the adjacent east bank (Table 27; Figure 7). Average macroinvertebrate densities were lower in the habitat influenced by the effluent plumes relative to unaffected reference areas near the opposite bank. The inference is that the bottom-dwelling macroinvertebrate community in the direct path of the raw sewage overflow may have been impacted. Conversely, mean densities in the reference samples collected from the near-shore areas adjacent to the unaffected east bank were considerably higher than all other samples, including the pre-event samples collected at Selkirk (Table 27). Moreover, there were no statistically significant differences between samples collected from the plume areas near Jefferson Avenue and Kildonan Park and samples collected from Selkirk prior to the spill event (Table 27). Therefore, it is not known whether the differences observed in macroinvertebrate densities between the west and east banks were due to impacts from the raw sewage overflow event or to normal variability due to within-stream substrate preferences.

LAKE WINNIPEG BEACH MONITORING

- Every summer, major beaches in Manitoba, including those on the east and west sides of Lake Winnipeg are routinely monitored for recreational water quality. Recreational water quality guidelines for fecal coliform bacteria such as *E. coli* are used to protect bathers from contamination by organisms with the potential to cause disease.
- Routine summer monitoring for bacterial densities at beaches on both the east and west sides of Lake Winnipeg was extended through to the end of September to assess the impact of the North Winnipeg Water Pollution Control Centre sewage release on recreational water quality. However, considering the distance between the mouth of the Red River and the Lake Winnipeg beaches, and the considerable dilution expected in the lake, it was not anticipated that bacterial densities would be impacted. In addition, the highest bacterial densities observed near the mouth of the Red River (RR13) were only slightly above the recreational water quality guideline (290/100 mL) suggesting that travel distance and dilution would reduce densities to below to water quality guideline.
- Bacterial densities were monitored at 10 beaches on the east and west sides of Lake Winnipeg on September 18, 20, 23, and 26, 2002. With the exception of the station at the Victoria Beach Red Cross Dock where only one replicate was collected, 5 replicate samples were collected along the length of the beach. The geomean of the bacterial densities from each replicate was calculated for each station on every sampling day and compared to the recreation water quality guideline of 200 *E. coli* per 100 ml of sample.
- With the exception of on September 20 and 23, 2002 at Gimli Beach, and on September 23, 2002 at Winnipeg Beach, all geometric means were below the recreational water quality guideline of 200 *E. coli* per 100 ml of sample (Table 26).
- Since the plume from the North Winnipeg Pollution Control Centre sewage release did not reach the mouth of Lake Winnipeg until September 20, 2002, elevated bacterial densities recorded at Gimli (503/100 mL), over 30 km away, on that same day were not related to the sewage release.
- Elevated bacterial densities recorded on September 23, 2002 at Winnipeg Beach (287/100 mL) and Gimli (231/100 mL) were also likely unrelated to the North Winnipeg Pollution Control sewage release given that similar increases in bacterial densities did not occur at other beaches located closer to the mouth of the Red River.
- Elevated bacterial densities at beaches during the September and October are often related to wildlife activities. Staging birds were observed on the beach during sampling in September 2002.

FIGURES

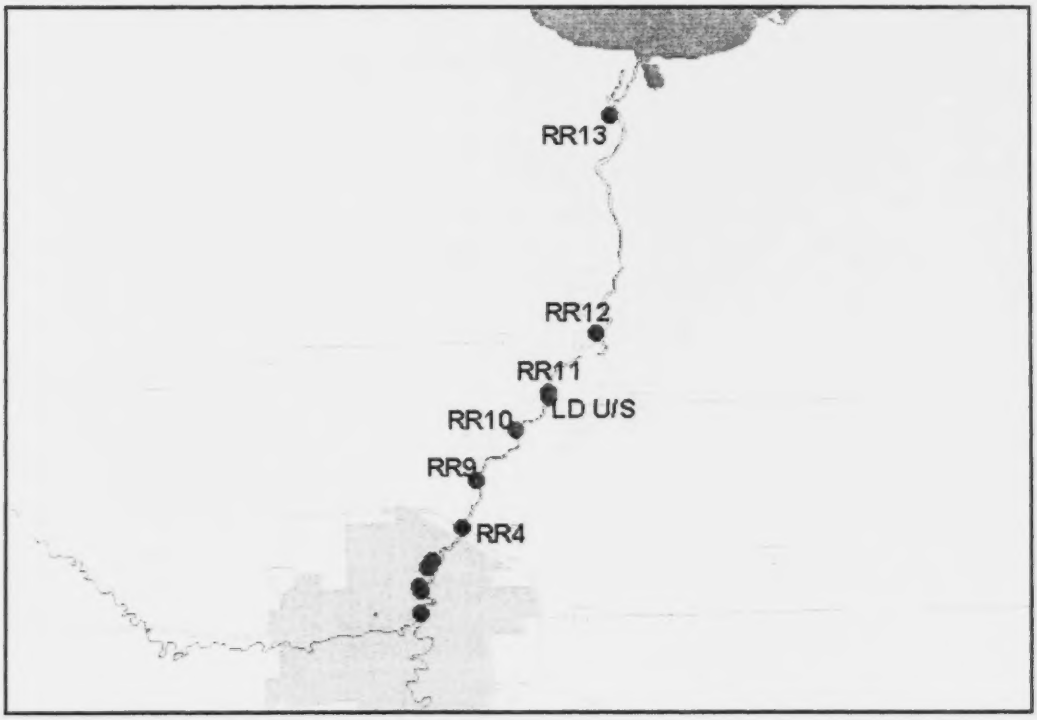

Figure 1. Overview of all sampling stations on the Red River.

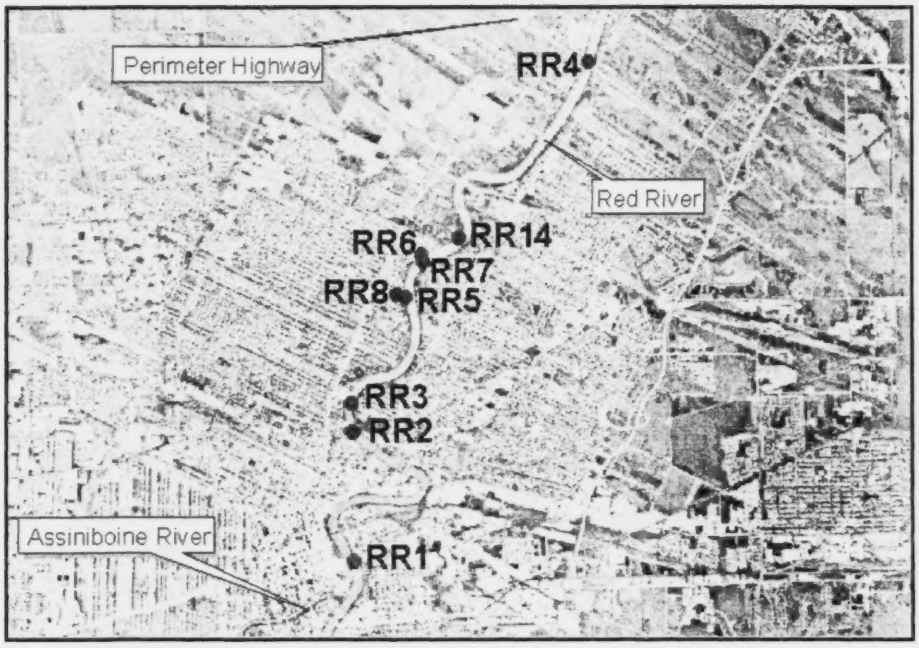

Figure 2. Aerial photo of all Red River sampling stations within the City of Winnipeg.

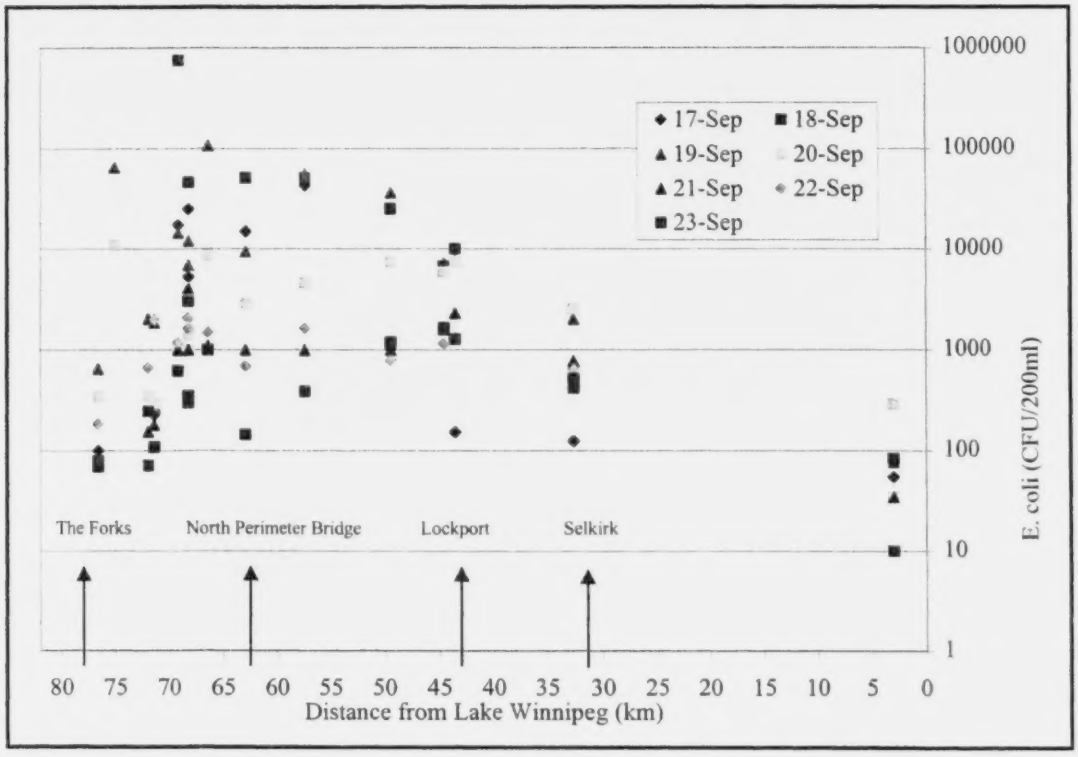

Figure 3. Change in *Escherichia coli* densities with distance from Lake Winnipeg.

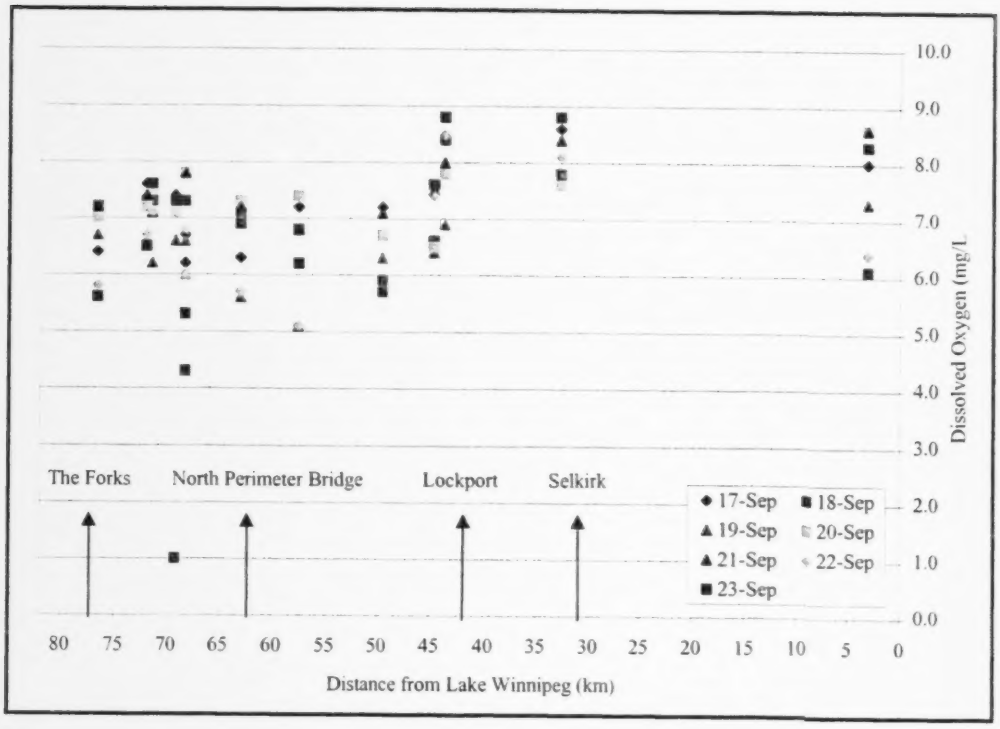

Figure 4. Change in dissolved oxygen concentration with distance from Lake Winnipeg.

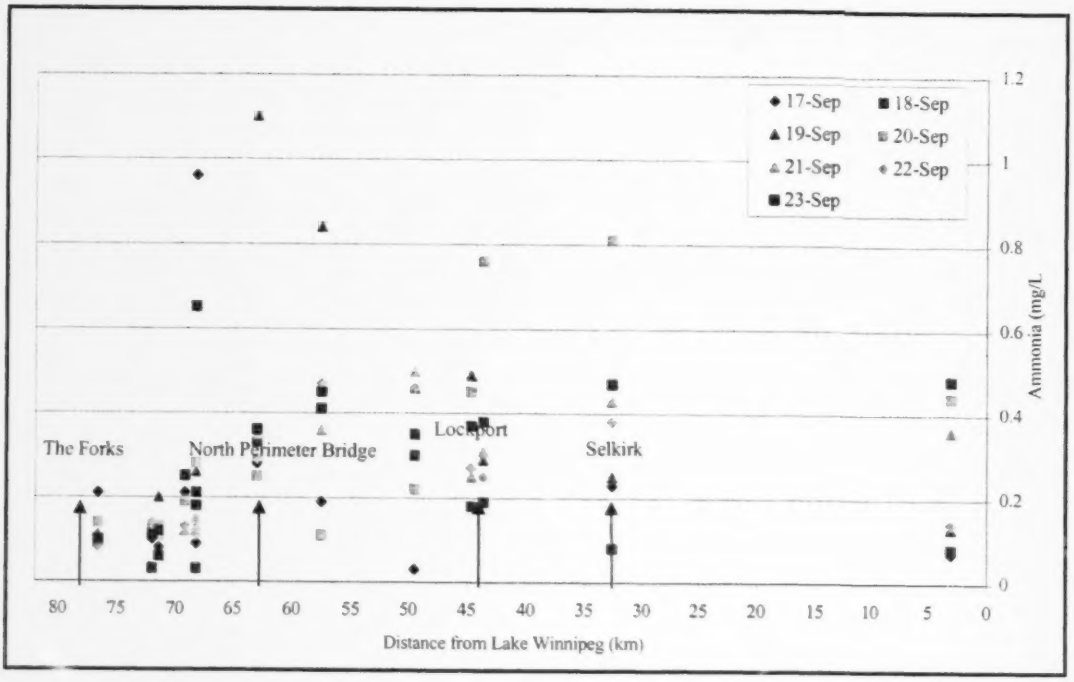

Figure 5. Change in ammonia concentration with distance from Lake Winnipeg.

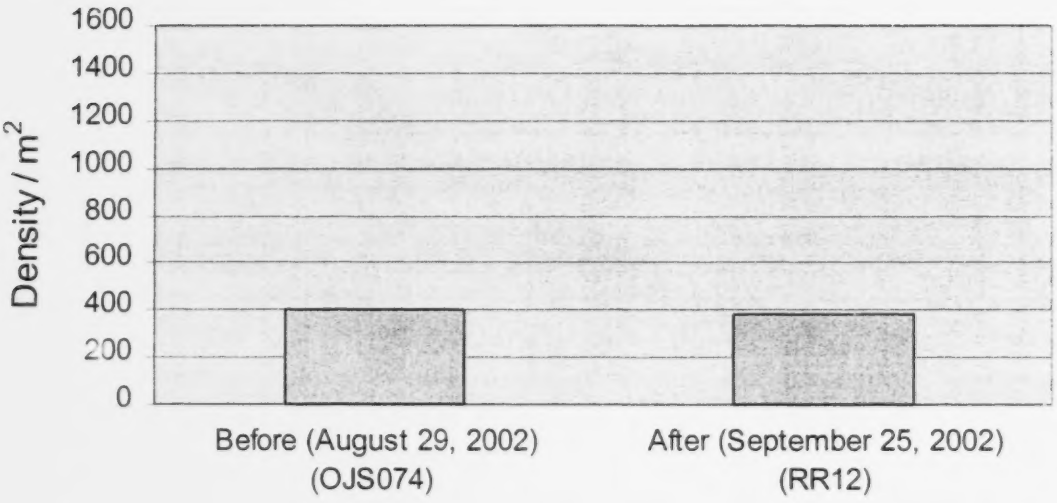

Figure 6. Average macroinvertebrate densities (organisms/m^2) in the Red River near Selkirk approximately 18 days before and immediately after the overflow of raw sewage from the City of Winnipeg in September 2002.

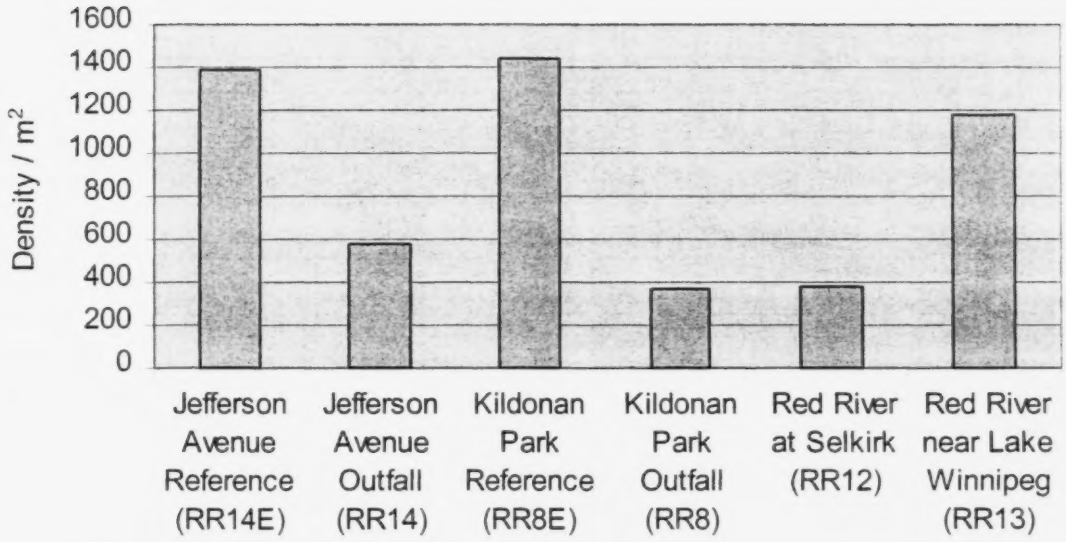

Figure 7. Average macroinvertebrate densities (organisms/m^2) in the Red River immediately following overflow of raw sewage from the City of Winnipeg in September 2002.

TABLES

Table 1. Red River sampling stations and descriptions.

Station	Station Description
RR1	Provencher Bridge
RR2	Between Disraeli and Redwood Bridges
RR3 - top	Redwood Bridge
RR3 - bottom	Redwood Bridge
RR5	End of plume downstream of Jefferson Outfall
RR8	Within plume of Jefferson Outfall
RR6	West Shore near Marymound School
RR7	East Shore near Marymound School
RR4	North Perimeter Bridge
RR9	Downstream of Rivercrest
RR10	Near Twin Oaks, Downstream from Scott House
LD U/S	Upstream of Lockport Dam
RR11	Downstream of Lockport Dam
RR12	Selkirk Bridge
RR13	Red River 3 km upstream of Lake Winnipeg
RR14	Within plume of Kildonan Park outfall

Table 2. pH (pH units) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	7.90	7.96	7.93	7.98	7.88	7.77	8.21
RR2	Between Disraeli and Redwood Bridges	7.93	8.03	8.03	8.1	8.01	7.94	8.24
RR3 - top	Redwood Bridge	7.96	8.06	8.05	8.11	8.05	7.30	8.23
RR3 - bottom	Redwood Bridge	7.98	8.08	8.06	8.2	8.17	8.10	8.26
RR5	End of plume downstream of Jefferson Outfall	7.99	7.41	8.08	8.09	8.04	8.11	8.23
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	7.91	8.04	8.1	8.1	8.05	8.16	8.19
RR7	East Shore near Marymound School	8.02	8.08	8.12	8.12	8.1	8.10	8.26
RR4	North Perimeter Bridge	7.93	8.05	7.89	8.08	8.04	8.05	8.2
RR9	Downstream of Rivercrest	7.87	7.9	7.87	8.08	8.05	8.09	8.15
RR10	Near Twin Oaks, Downstream from Scott House	8.03	7.92	8.09	8	8.02	8.06	8.14
LD U/S	Upstream of Lockport Dam		8.01	8.12	7.93	8.07	8.15	8.07
RR11	Downstream of Lockport Dam		8.03	8.1	7.95	8.08	8.17	8.18
RR12	Selkirk Bridge	7.98	8.12	8.12	8.09	8.02	8.05	8.15
RR13	Red River 3 km upstream of Lake Winnipeg	8.02	8.14	8.16	8.2	8.12	8.15	8.14

Table 3. Conductivity (µs/cm) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	707	700	682	654	635	672	683
RR2	Between Disraeli and Redwood Bridges	680	707	700	704	682	696	681
RR3 - top	Redwood Bridge	680	706	698	715	676	710	679
RR3 - bottom	Redwood Bridge	682	708	692	710	678	690	674
RR5	End of plume downstream of Jefferson Outfall	685	1074	711	720	683	698	680
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	698	710	708	718	686	695	679
RR7	East Shore near Marymound School	680	710	711	721	678	696	678
RR4	North Perimeter Bridge	681	696	727	720	696	693	679
RR9	Downstream of Rivercrest	672	707	708	720	694	687	677
RR10	Near Twin Oaks, Downstream from Scott House	670	697	708	716	717	688	690
LD U/S	Upstream of Lockport Dam		679	697	725	708	695	685
RR11	Downstream of Lockport Dam		681	694	719	713	691	683
RR12	Selkirk Bridge	672	677	680	711	710	715	684
RR13	Red River 3 km upstream of Lake Winnipeg	632	524	634	648	359	631	689

Table 4. Turbidity (NTU) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	39	35	32	35	40	43	46
RR2	Between Disraeli and Redwood Bridges	40	30	24	35	35	42	41
RR3 - top	Redwood Bridge	38	28	24	35	35	41	37
RR3 - bottom	Redwood Bridge	38	32	25	36	39	44	43
RR5	End of plume downstream of Jefferson Outfall	41	46	22	32	35	36	33
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	34	24	24	31	35	39	35
RR7	East Shore near Marymound School	35	27	21	28	32	36	34
RR4	North Perimeter Bridge	32	23	20	27	29	34	31
RR9	Downstream of Rivercrest	26	22	17	27	28	31	32
RR10	Near Twin Oaks, Downstream from Scott House	31	22	16	18	22	24	26
LD U/S	Upstream of Lockport Dam		19	16	19	23	23	24
RR11	Downstream of Lockport Dam		22	18	21	22	24	25
RR12	Selkirk Bridge	35	26	18	24	21	22	24
RR13	Red River 3 km upstream of Lake Winnipeg	48	43	41	52	73	34	35

Table 5. Total dissolved solids (mg/L) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	495	479	450	443	410	433	477
RR2	Between Disraeli and Redwood Bridges	461	458	457	467	440	460	460
RR3 - top	Redwood Bridge	464	468	462	501	458	445	474
RR3 - bottom	Redwood Bridge	473	497	461	489	443	457	468
RR5	End of plume downstream of Jefferson Outfall	463	567	447	506	440	465	466
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	457	466	464	491	438	457	464
RR7	East Shore near Marymound School	470	484	460	497	447	453	451
RR4	North Perimeter Bridge	443	480	471	476	413	447	433
RR9	Downstream of Rivercrest	459	455	468	504	454	457	445
RR10	Near Twin Oaks, Downstream from Scott House	445	469	480	488	454	462	456
LD U/S	Upstream of Lockport Dam		449	463	491	484	451	448
RR11	Downstream of Lockport Dam		445	463	494	459	456	467
RR12	Selkirk Bridge	445	458	450	489	465	457	460
RR13	Red River 3 km upstream of Lake Winnipeg	427	337	432	442	256	422	462

Table 6. Total suspended solids (mg/L) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	58	59	44	51	60	68	86
RR2	Between Disraeli and Redwood Bridges	58	51	39	51	58	72	74
RR3 - top	Redwood Bridge	50	42	36	50	60	72	59
RR3 - bottom	Redwood Bridge	58	51	39	57	60	80	78
RR5	End of plume downstream of Jefferson Outfall	57	100	31	50	59	62	56
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	57	40	35	41	59	65	57
RR7	East Shore near Marymound School	51	40	32	39	52	61	56
RR4	North Perimeter Bridge	40	36	28	36	44	55	44
RR9	Downstream of Rivercrest	40	34	25	34	41	50	50
RR10	Near Twin Oaks, Downstream from Scott House	40	29	21	24	33	36	38
LD U/S	Upstream of Lockport Dam		25	25	26	33	34	32
RR11	Downstream of Lockport Dam		32	26	30	34	35	29
RR12	Selkirk Bridge	53	38	30	32	39	34	35
RR13	Red River 3 km upstream of Lake Winnipeg	76	51	67	89	115	56	66

Table 7. Dissolved oxygen (mg/L) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	6.4	7.2	6.7	7	7.2	5.8	5.6
RR2	Between Disraeli and Redwood Bridges	7.6	7.3	6.6	7.2	7.4	6.7	6.5
RR3 - top	Redwood Bridge	7.5	7.3	6.2	7.5	7.1	7.1	7.6
RR3 - bottom	Redwood Bridge	6.8	7.5	5.6	7.1	7.9	7.0	7.8
RR5	End of plume downstream of Jefferson Outfall	7.4	1	6.6	7.1	7.4	7.2	7.3
RR8	Within plume of Jefferson Outfall	< 0.1	< 0.1	5.7	7.8	7.8	6.9	6.2
RR6	West Shore near Marymound School	6.2	7.3	6	7.8	7.8	6.0	5.3
RR7	East Shore near Marymound School	6.7	7.3	6.6	7.8	7.8	6.8	4.3
RR4	North Perimeter Bridge	6.3	7.1	5.6	7.3	7.2	5.7	6.9
RR9	Downstream of Rivercrest	7.2	6.8	5.1	7.4	6.8	5.1	6.2
RR10	Near Twin Oaks, Downstream from Scott House	7.2	5.9	6.3	6.7	7.1	6.7	5.7
LD U/S	Upstream of Lockport Dam		6.6	6.4	6.5	7.5	7.4	7.6
RR11	Downstream of Lockport Dam		8.4	6.9	7.8	8	8.5	8.8
RR12	Selkirk Bridge	8.6	7.8	7.8	7.6	8.4	8.1	8.8
RR13	Red River 3 km upstream of Lake Winnipeg	8.0	6.1	7.3	8.6	8.6	6.4	8.3

Table 8. Biochemical oxygen demand (mg/L) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	2	3	2	1	<1	<1	<1
RR2	Between Disraeli and Redwood Bridges	4	2	3	3	2	<1	1
RR3 - top	Redwood Bridge	3	5	4	3	2	<1	<1
RR3 - bottom	Redwood Bridge	5	4	6	4	4	<1	1
RR5	End of plume downstream of Jefferson Outfall	7	17	4	3	2	2	3
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	11	11	4	3	2	2	3
RR7	East Shore near Marymound School	5	5	5	5	2	2	3
RR4	North Perimeter Bridge	6	5	10	4	5	<1	3
RR9	Downstream of Rivercrest	4	3	8	4	3	2	4
RR10	Near Twin Oaks, Downstream from Scott House	5	3	6	5	3	4	2
LD U/S	Upstream of Lockport Dam		4	9	5	4	2	2
RR11	Downstream of Lockport Dam		3	6	6	3	3	5
RR12	Selkirk Bridge	4	5	5	2	5	2	3
RR13	Red River 3 km upstream of Lake Winnipeg	6	7	6	2	2	<1	3

Table 9. Total Kjeldahl ntrogen (mg/L) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
	Provencher Bridge	1.4	0.9	0.7	1.3	1.4	1.3	1.6
RR2	Between Disraeli and Redwood Bridges	1.3	0.9	0.5	1.3	1.3	1.3	1.9
RR3 - top	Redwood Bridge	1.2	0.6	0.6	1.3	< 0.2	1.4	2.1
RR3 - bottom	Redwood Bridge	1.2	< 0.2	0.7	< 0.2	< 0.2	1.5	2
RR5	End of plume downstream of Jefferson Outfall	1.2	17.9	0.7	1.4	0.5	1.8	2.1
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	1.2	1.1	0.7	1.3	1.7	2	2
RR7	East Shore near Marymound School	1.3	0.2	0.5	1.5	0.2	1.7	2.1
RR4	North Perimeter Bridge	0.7	1.4	1.1	1.1	1	1.4	1.9
RR9	Downstream of Rivercrest	1	3.3	1	0.9	0.4	1.8	2.3
RR10	Near Twin Oaks, Downstream from Scott House	0.9	1.0	0.9	0.6	1.5	2	1.8
LD U/S	Upstream of Lockport Dam		0.8	0.5	1.2	1.5	1.9	2
RR11	Downstream of Lockport Dam		0.8	0.9	1.2	1.7	1.6	2.1
RR12	Selkirk Bridge	1.2	0.7	3.3	0.9	1.5	1.7	2.3
RR13	Red River 3 km upstream of Lake Winnipeg	0.7	0.5	0.5	0.5	0.9	1.5	2.1

Table 10. Nitrate-nitrite (mg/L) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	0.4	0.4	0.46	0.45	0.49	0.43	0.37
RR2	Between Disraeli and Redwood Bridges	0.41	0.37	0.38	0.36	0.41	0.41	0.4
RR3 - top	Redwood Bridge	0.41	0.38	0.39	0.38	0.41	0.41	0.41
RR3 - bottom	Redwood Bridge	0.4	0.39	0.39	0.37	0.41	0.41	0.41
RR5	End of plume downstream of Jefferson Outfall	0.41	< 0.01	0.37	0.37	0.42	0.4	0.4
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	0.43	0.38	0.38	0.96	0.4	0.41	0.41
RR7	East Shore near Marymound School	0.43	0.39	0.39	0.39	0.42	0.41	0.41
RR4	North Perimeter Bridge	0.44	0.4	0.56	0.38	0.43	0.42	0.42
RR9	Downstream of Rivercrest	0.46	0.42	0.62	0.39	0.43	0.43	0.44
RR10	Near Twin Oaks, Downstream from Scott House	0.44	0.45	0.45	0.46	0.48	0.52	0.49
LD U/S	Upstream of Lockport Dam		0.47	0.47	0.59	0.44	0.47	0.49
RR11	Downstream of Lockport Dam		0.48	0.5	0.64	0.46	0.47	0.48
RR12	Selkirk Bridge	0.66	0.46	0.5	0.49	0.56	0.53	0.56
RR13	Red River 3 km upstream of Lake Winnipeg	0.59	0.5	0.59	0.49	0.32	0.51	0.61

Table 11. Ammonia (mg/L) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	0.21	0.09	0.11	0.14	0.14	0.08	0.1
RR2	Between Disraeli and Redwood Bridges	0.1	0.03	0.14	0.12	0.12	0.14	0.11
RR3 - top	Redwood Bridge	0.08	0.06	0.2	0.13	0.11	0.11	0.12
RR3 - bottom	Redwood Bridge	0.07	0.04	0.15	0.11	0.11	0.1	0.2
RR5	End of plume downstream of Jefferson Outfall	0.21	15.2	0.2	0.19	0.12	0.13	0.25
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	0.96	0.65	0.26	0.21	0.13	0.12	0.21
RR7	East Shore near Marymound School	0.09	0.03	0.15	0.28	0.15	0.11	0.18
RR4	North Perimeter Bridge	0.28	0.33	1.1	0.25	0.35	0.29	0.36
RR9	Downstream of Rivercrest	0.19	0.41	0.84	0.11	0.36	0.47	0.45
RR10	Near Twin Oaks, Downstream from Scott House	0.03	0.3	0.46	0.22	0.5	0.46	0.35
LD U/S	Upstream of Lockport Dam		0.18	0.49	0.45	0.25	0.27	0.37
RR11	Downstream of Lockport Dam		0.19	0.29	0.76	0.31	0.25	0.38
RR12	Selkirk Bridge	0.23	0.08	0.25	0.81	0.43	0.38	0.47
RR13	Red River 3 km upstream of Lake Winnipeg	0.07	0.08	0.13	0.44	0.36	0.14	0.48

Table 12. Acid hydrolyzable phosphorus (mg/L) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	0.224	0.116	0.1	0.118	0.123	0.172	0.177
RR2	Between Disraeli and Redwood Bridges	0.137	0.116	0.099	0.089	0.109	0.147	0.166
RR3 - top	Redwood Bridge	0.126	0.123	0.119	0.108	0.159	0.111	0.149
RR3 - bottom	Redwood Bridge	0.165	0.118	0.199	0.116	0.133	0.202	0.148
RR5	End of plume downstream of Jefferson Outfall	0.115	2.51	0.12	0.133	0.138	0.104	0.149
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	0.216	0.103	0.14	0.078	0.115	0.13	0.155
RR7	East Shore near Marymound School	0.097	0.109	0.114	0.128	0.11	0.105	0.135
RR4	North Perimeter Bridge	0.131	0.08	0.062	0.092	0.146	0.139	0.112
RR9	Downstream of Rivercrest	0.119	0.063	0.092	0.094	0.102	0.13	0.089
RR10	Near Twin Oaks, Downstream from Scott House	0.13	0.103	0.066	0.071	0.087	0.081	0.119
LD U/S	Upstream of Lockport Dam		0.104	0.067	0.096	0.087	0.044	0.071
RR11	Downstream of Lockport Dam		0.099	0.09	0.086	0.111	0.099	0.069
RR12	Selkirk Bridge	0.142	0.091	0.077	0.08	0.124	0.174	0.085
RR13	Red River 3 km upstream of Lake Winnipeg	0.195	0.131	0.16	0.177	0.219	0.128	0.144

Table 13. Total soluble phosphorus (mg/L) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	0.139	0.146	0.132	0.131	0.141	0.137	0.124
RR2	Between Disraeli and Redwood Bridges	0.139	0.142	0.143	0.133	0.174	0.139	0.141
RR3 - top	Redwood Bridge	0.141	0.145	0.14	0.128	0.148	0.137	0.144
RR3 - bottom	Redwood Bridge	0.143	0.144	0.138	0.134	0.130	0.139	0.145
RR5	End of plume downstream of Jefferson Outfall	0.152	0.562	0.143	0.138	0.143	0.134	0.151
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	0.190	0.221	0.144	0.145	0.141	0.139	0.15
RR7	East Shore near Marymound School	0.147	0.156	0.143	0.145	0.141	0.137	0.152
RR4	North Perimeter Bridge	0.163	0.175	0.298	0.143	0.158	0.163	0.165
RR9	Downstream of Rivercrest	0.175	0.168	0.256	0.19	0.162	0.177	0.172
RR10	Near Twin Oaks, Downstream from Scott House	0.154	0.175	0.185	0.144	0.184	0.174	0.163
LD U/S	Upstream of Lockport Dam		0.161	0.173	0.261	0.161	0.157	0.169
RR11	Downstream of Lockport Dam		0.164	0.176	0.275	0.167	0.156	0.165
RR12	Selkirk Bridge	0.198	0.148	0.176	0.186	0.211	0.177	0.174
RR13	Red River 3 km upstream of Lake Winnipeg	0.173	0.140	0.171	0.149	0.115	0.158	0.205

Table 14 Total particulate phosphorus (mg/L) at 14 stations on the Red River

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	0.171	0.154	0.131	0.123	0.137	0.179	0.196
RR2	Between Disraeli and Redwood Bridges	0.155	0.135	0.121	0.159	0.115	0.176	0.171
RR3 - top	Redwood Bridge	0.136	0.131	0.142	0.154	0.15	0.179	0.166
RR3 - bottom	Redwood Bridge	0.144	0.134	0.124	0.161	0.168	0.187	0.157
RR5	End of plume downstream of Jefferson Outfall	0.158	0.677	0.133	0.165	0.142	0.181	0.157
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	0.227	0.157	0.124	0.152	0.148	0.164	0.159
RR7	East Shore near Marymound School	0.136	0.112	0.115	0.142	0.138	0.158	0.143
RR4	North Perimeter Bridge	0.13	0.122	0.11	0.126	0.133	0.147	0.135
RR9	Downstream of Rivercrest	0.134	0.117	0.138	0.07	0.13	0.137	0.135
RR10	Near Twin Oaks, Downstream from Scott House	0.136	0.11	0.107	0.151	0.118	0.123	0.126
LD U/S	Upstream of Lockport Dam		0.099	0.091	0.104	0.109	0.118	0.118
RR11	Downstream of Lockport Dam		0.1	0.103	0.103	0.114	0.116	0.122
RR12	Selkirk Bridge	0.164	0.117	0.097	0.108	0.111	0.139	0.122
RR13	Red River 3 km upstream of Lake Winnipeg	0.205	0.161	0.17	0.22	0.261	0.142	0.077

Table 15 Total phosphorus (mg/L) at 14 stations on the Red River

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	0.310	0.300	0.263	0.254	0.278	0.316	0.320
RR2	Between Disraeli and Redwood Bridges	0.294	0.277	0.264	0.292	0.289	0.315	0.312
RR3 - top	Redwood Bridge	0.277	0.276	0.282	0.282	0.298	0.316	0.310
RR3 - bottom	Redwood Bridge	0.287	0.278	0.262	0.295	0.298	0.326	0.302
RR5	End of plume downstream of Jefferson Outfall	0.310	1.24	0.276	0.303	0.285	0.315	0.308
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	0.417	0.378	0.268	0.297	0.289	0.303	0.309
RR7	East Shore near Marymound School	0.283	0.268	0.258	0.287	0.279	0.295	0.295
RR4	North Perimeter Bridge	0.293	0.297	0.408	0.269	0.291	0.310	0.300
RR9	Downstream of Rivercrest	0.309	0.285	0.394	0.26	0.292	0.314	0.307
RR10	Near Twin Oaks, Downstream from Scott House	0.290	0.285	0.292	0.295	0.302	0.297	0.289
LD U/S	Upstream of Lockport Dam		0.260	0.264	0.365	0.27	0.275	0.287
RR11	Downstream of Lockport Dam		0.264	0.279	0.378	0.281	0.272	0.287
RR12	Selkirk Bridge	0.362	0.265	0.273	0.294	0.322	0.316	0.296
RR13	Red River 3 km upstream of Lake Winnipeg	0.378	0.300	0.341	0.369	0.376	0.300	0.382

Table 16. Total reactive phosphorus (mg/L) at 14 stations on the Red River

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	0.05	0.151	0.143	0.112	0.144	0.117	0.096
RR2	Between Disraeli and Redwood Bridges	0.128	0.122	0.139	0.166	0.138	0.13	0.104
RR3 top	Redwood Bridge	0.124	0.122	0.153	0.147	0.122	0.162	0.114
RR3 bottom	Redwood Bridge	0.097	0.125	0.14	0.131	0.13	0.083	0.120
RR5	End of plume downstream of Jefferson Outfall	0.170	1.09	0.117	0.126	0.124	0.148	0.110
RR8	Within plume of Jefferson Outfall							
RR6	West Shore near Marymound School	0.194	0.236	0.100	0.173	0.137	0.129	0.123
RR7	East Shore near Marymound School	0.163	0.137	0.115	0.135	0.14	0.135	0.145
RR4	North Perimeter Bridge	0.138	0.180	0.321	0.15	0.116	0.124	0.147
RR9	Downstream of Rivercrest	0.146	0.202	0.26	0.129	0.16	0.152	0.178
RR10	Near Twin Oaks, Downstream from Scott House	0.123	0.155	0.188	0.178	0.187	0.182	0.146
LD U/S	Upstream of Lockport Dam		0.133	0.172	0.232	0.151	0.195	0.181
RR11	Downstream of Lockport Dam		0.139	0.162	0.249	0.139	0.142	0.166
RR12	Selkirk Bridge	0.161	0.154	0.166	0.176	0.168	0.099	0.173
RR13	Red River 3 km upstream of Lake Winnipeg	0.144	0.150	0.172	0.159	0.127	0.146	0.194

Table 17. *Escherichia coli* densities (Colony forming units per 100 mL) at 14 stations on the Red River (September 17 to 20, 2002).

Station	Station Description	17-Sep-02	17-Sep-02	17-Sep-02	18-Sep-02	18-Sep-02	19-Sep-02	19-Sep-02	20-Sep-02	20-Sep-02
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
RR1	Provencher Bridge	100	100		90	70	860	490	310	380
RR2	Between Disraeli and Redwood Bridges	70	70		100	50	2220	1840	250	480
RR3 - top	Redwood Bridge	170	300		130	500	1700	2040	330	260
RR3 - bottom	Redwood Bridge									
RR5	End of plume downstream of Jefferson Outfall	19200	15400		800000	700000	16000	13000	<1000	1000
RR8	Within plume of Jefferson Outfall									
RR6	West Shore near Marymound School	24000	25900		46000	46000	12000	12000	<1000	<1000
RR7	East Shore near Marymound School	5760	4800		3000	3000	6900	6800	2000	<1000
RR4	North Perimeter Bridge	14400	15400		48000	54000	9500	9400	2000	4000
RR9	Downstream of Rivercrest	38400	48000		56000	46000	57000	56000	7000	3000
RR10	Near Twin Oaks, Downstream from Scott House	1000	1080		23000	27800	35000	38000	9000	6000
LD U/S	Upstream of Lockport Dam				6720	6720	7800	6800	7000	5000
RR11	Downstream of Lockport Dam	110	160	200	10560	9600	7600	7900	7200	7500
RR12	Selkirk Bridge	170	90		470	370	1760	2300	2380	2700
RR13	Red River 3 km upstream of Lake Winnipeg	50	60		10	10	120	50	120	700
	North End Water Pollution Control Centre Outfall						86400	134000	9800	7700
	Near Bannatyne Street						58000	72000	10000	12000

Table 18. *Escherichia coli* densities (Colony forming units per 100 mL) at 14 stations on the Red River (September 21 to 23, 2002).

Station	Station Description	21-Sep-02	21-Sep-02	22-Sep-02	22-Sep-02	23-Sep-02	23-Sep-02
		Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
RR1	Provencher Bridge	40	40 (210)	190	180	100	50
RR2	Between Disraeli and Redwood Bridges	170	140	630	690	200	300
RR3 - top	Redwood Bridge	190	170	1700	2300	130	90
RR3 - bottom	Redwood Bridge						
RR5	End of plume downstream of Jefferson Outfall	1000	no duplicate	770	1800	600	630
RR8	Within plume of Jefferson Outfall						
RR6	West Shore near Marymound School	4000	4000	1900	1400	290	310
RR7	East Shore near Marymound School	<1000	1000	2300	1800	400	300
RR4	North Perimeter Bridge	1000	<1000	710	670	160	130
RR9	Downstream of Rivercrest	<1000	1000	1500	1800	500	300
RR10	Near Twin Oaks, Downstream from Scott House	1000	1000	620	1000	1000	1400
LD U/S	Upstream of Lockport Dam	1700	1500	1300	1000	1500	1800
RR11	Downstream of Lockport Dam	2200	2400	1700	1000	1000	1600
RR12	Selkirk Bridge	860	690	700	600	470	570
RR13	Red River 3 km upstream of Lake Winnipeg	20	60	70	100	100	70
	North End Water Pollution Control Centre Outfall Near Bannatyne Street	1000	1200	1300	1700	900	1100

Table 19. Fecal coliform densities (Colony forming units per 100 mL) at 14 stations on the Red River (September 17 to 20, 2002).

Station	Station Description	17-Sep-02	17-Sep-02	17-Sep-02	18-Sep-02	18-Sep-02	19-Sep-02	19-Sep-02	20-Sep-02	20-Sep-02
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
RR1	Provencher Bridge	120	110		180	50	1430	1080	450	350
RR2	Between Disraeli and Redwood Bridges	50	70		220	130	3140	2650	660	580
RR3 - top	Redwood Bridge	150	1060		230	680	2880	10500	620	840
RR3 - bottom	Redwood Bridge									
RR5	End of plume downstream of Jefferson Outfall	28800	30700		800000	1200000	44000	26000	2000	1000
RR8	Within plume of Jefferson Outfall									
RR6	West Shore near Marymound School	36500	41300		70000	83000	23000	23000	1000	2000
RR7	East Shore near Marymound School	14400	10200		3000	<100	13200	12900	1000	<1000
RR4	North Perimeter Bridge	30700	29800		61000	164000	15700	38600	4000	3000
RR9	Downstream of Rivercrest	20200	20200		52000	65000	108000	84000	6000	4000
RR10	Near Twin Oaks, Downstream from Scott House	1450	1380		20200	18200	57000	57000	10000	10000
LD U/S	Upstream of Lockport Dam				8640	10560	13300	15700	15000	22000
RR11	Downstream of Lockport Dam	140	420		9600	8640	13400	14400	10600	12000
RR12	Selkirk Bridge	190	210		540	430	1930	2670	2800	3840
RR13	Red River 3 km upstream of Lake Winnipeg	50	70	280	10	20	120	20	270	400
	North End Water Pollution Control Centre Outfall						382000	438000	118000	10100
	Near Bannatyne Street						125000	232000	29000	23000

Table 20. Fecal coliform densities (Colony forming units per 100 mL) at 14 stations on the Red River (September 21 to 23, 2002).

Station	Station Description	21-Sep-02	21-Sep-02	22-Sep-02	22-Sep-02	23-Sep-02	23-Sep-02
		Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2
RR1	Provencher Bridge	120	30 (410)	200	220	200	60
RR2	Between Disraeli and Redwood Bridges	310	220	820	2900	500	100
RR3 – top	Redwood Bridge	330	340	3100	2700	370	310
RR3 – bottom	Redwood Bridge						
RR5	End of plume downstream of Jefferson Outfall	<1000	no duplicate	3900	3200	840	830
RR8	Within plume of Jefferson Outfall						
RR6	West Shore near Marymound School	4000	<1000	2500	1380	630	570
RR7	East Shore near Marymound School	2000	<1000	2000	2000	400	450
RR4	North Perimeter Bridge	3000	1000	2100	2900	580	470
RR9	Downstream of Rivercrest	5000	<1000	2200	3000	1300	1500
RR10	Near Twin Oaks, Downstream from Scott House	6000	3000	970	2100	1700	1500
LD U/S	Upstream of Lockport Dam	2000	5000	2200	900	960	920
RR11	Downstream of Lockport Dam	3500	2800	2100	880	890	830
RR12	Selkirk Bridge	1000	940	1400	1300	690	690
RR13	Red River 3 km upstream of Lake Winnipeg	30	80	110	180	170	200
	North End Water Pollution Control Centre Outfall	800	2600	3600	3600	150	910
	Near Bannatyne Street						

Table 21. Concentrations of trace metals at 14 stations on the Red River on September 20, 2002.

Station	Station Description	Total Aluminum	Total Antimony	Total Arsenic	Total Barium	Total Beryllium	Total Bismuth	Total Boron	Total Cadmium	Total Calcium
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
RR1	Provencher Bridge	0.64	0.0006	0.0041	0.068	< 0.0002	< 0.0002	0.08	< 0.00004	62.3
RR2	Between Disraeli and Redwood Bridges	0.62	0.0006	0.0045	0.072	< 0.0002	< 0.0002	0.09	0.0001	61.8
RR3 top	Redwood Bridge	0.69	0.0007	0.0047	0.074	< 0.0002	< 0.0002	0.1	0.00019	63.1
RR3 bottom	Redwood Bridge	0.89	0.0006	0.0045	0.074	< 0.0002	< 0.0002	0.11	< 0.00004	59.2
RR5	End of plume downstream of Jefferson Outfall	0.62	0.0006	0.0045	0.072	< 0.0002	< 0.0002	0.12	< 0.00004	65.5
RR6	West Shore near Marymound School	0.69	0.0006	0.0046	0.072	< 0.0002	< 0.0002	0.09	< 0.00004	61.2
RR7	East Shore near Marymound School	0.57	0.0006	0.0044	0.07	< 0.0002	< 0.0002	0.09	< 0.00004	60.3
RR4	North Perimeter Bridge	0.67	0.0008	0.0044	0.071	< 0.0002	< 0.0002	0.1	< 0.00004	67
RR9	Downstream of Rivercrest	0.6	0.0006	0.0042	0.07	< 0.0002	< 0.0002	0.11	< 0.00004	59.7
RR10	Near Twin Oaks, Downstream from Scott House	0.5	0.0006	0.0041	0.067	< 0.0002	< 0.0002	0.11	< 0.00004	59.4
LD U/S	Upstream of Lockport Dam	0.41	0.0006	0.0041	0.068	< 0.0002	< 0.0002	0.11	< 0.00004	58
RR11	Downstream of Lockport Dam	0.59	0.0006	0.0041	0.069	< 0.0002	< 0.0002	0.11	< 0.00004	57.4
RR12	Selkirk Bridge	0.48	0.0006	0.004	0.07	< 0.0002	< 0.0002	0.09	< 0.00004	59
RR13	Red River 3 km upstream of Lake Winnipeg	1.17	0.0006	0.0043	0.074	< 0.0002	< 0.0002	0.1	< 0.00004	56.4

Table 21. Concentrations of trace metals at 14 stations on the Red River on September 20, 2002 (continued).

Station	Station Description	Total Cesium	Total Chromium	Total Cobalt	Total Copper	Total Iron	Total Lead	Total Lithium	Total Magnesium	Total Manganese
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
RR1	Provencher Bridge	0.0001	0.0008	0.0006	0.0039	0.89	0.0005	0.04	37.5	0.074
RR2	Between Disraeli and Redwood Bridges	0.0002	0.0009	0.0006	0.0034	1.06	0.0007	0.046	37.1	0.097
RR3 top	Redwood Bridge	0.0003	0.0011	0.0007	0.0037	0.99	0.0007	0.048	38.4	0.092
RR3 bottom	Redwood Bridge	0.0002	0.0013	0.0007	0.0048	1.44	0.0008	0.044	40.5	0.108
RR5	End of plume downstream of Jefferson Outfall	0.0001	0.001	0.0006	0.0047	1.02	0.0008	0.046	43.6	0.098
RR6	West Shore near Marymound School	0.0001	0.0011	0.0006	0.0033	1.1	0.0006	0.045	36.3	0.092
RR7	East Shore near Marymound School	0.0001	0.001	0.0006	0.0032	1.03	0.0006	0.043	35.4	0.087
RR4	North Perimeter Bridge	0.0001	0.001	0.0006	0.0036	0.95	0.0006	0.048	47.7	0.083
RR9	Downstream of Rivercrest	0.0001	0.001	0.0006	0.0035	0.93	0.0006	0.043	39.1	0.082
RR10	Near Twin Oaks, Downstream from Scott House	< 0.0001	0.0007	0.0004	0.0033	0.58	0.0004	0.046	41.2	0.063
LD U/S	Upstream of Lockport Dam	< 0.0001	0.0007	0.0004	0.0037	0.63	0.0004	0.044	38.2	0.075
RR11	Downstream of Lockport Dam	< 0.0001	0.001	0.0005	0.004	0.74	0.0005	0.046	37.9	0.077
RR12	Selkirk Bridge	< 0.0001	0.0014	0.0005	0.0036	0.77	0.0005	0.043	39.3	0.076
RR13	Red River 3 km upstream of Lake Winnipeg	0.0003	0.0017	0.0009	0.0044	1.94	0.001	0.039	37	0.124

Table 21. Concentrations of trace metals at 14 stations on the Red River on September 20, 2002 (continued).

Station	Station Description	Total Mercury	Total Molybdenum	Total Nickel	Total Phosphorus	Total Potassium	Total Rubidium	Total Selenium	Total Silicon	Total Silver
		ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
RR1	Provencher Bridge	0.04	0.0019	0.0043	0.7	6.61	0.0033	0.0006	27	< 0.00002
RR2	Between Disraeli and Redwood Bridges	0.04	0.0023	0.0043	0.72	6.97	0.0034	0.0006	23.3	< 0.00002
RR3 top	Redwood Bridge	0.04	0.0031	0.0043	0.76	7.19	0.0036	0.0008	24.6	< 0.00002
RR3 bottom	Redwood Bridge	0.04	0.0021	0.0046	0.77	7.09	0.0038	0.0006	24.6	< 0.00002
RR5	End of plume downstream of Jefferson Outfall	0.04	0.0023	0.0044	0.78	7.18	0.0034	0.0006	30.7	< 0.00002
RR6	West Shore near Marymound School	0.03	0.0023	0.0043	0.78	7.11	0.0034	0.0006	23.3	< 0.00002
RR7	East Shore near Marymound School	0.03	0.0022	0.0042	0.74	6.85	0.0032	0.0006	22.7	< 0.00002
RR4	North Perimeter Bridge	0.03	0.0023	0.0041	0.8	7.23	0.0033	0.0006	35	< 0.00002
RR9	Downstream of Rivercrest	0.05	0.0023	0.0049	0.71	6.83	0.0032	0.0006	26.3	< 0.00002
RR10	Near Twin Oaks, Downstream from Scott House	0.03	0.0021	0.0045	0.93	7.33	0.0029	0.0006	28.8	< 0.00002
LD U/S	Upstream of Lockport Dam	0.03	0.0023	0.0042	1.09	7.22	0.0029	0.0006	29.2	< 0.00002
RR11	Downstream of Lockport Dam	0.05	0.0024	0.0044	1.13	7.26	0.0032	0.0006	27.2	< 0.00002
RR12	Selkirk Bridge	0.03	0.0023	0.0039	0.83	6.97	0.0031	0.0006	29.5	< 0.00002
RR13	Red River 3 km upstream of Lake Winnipeg	0.04	0.0021	0.0051	0.85	6.96	0.0045	0.0006	26	< 0.00002

Table 21. Concentrations of trace metals at 14 stations on the Red River on September 20, 2002 (continued).

Station	Station Description	Total Sodium	Total Strontium	Total Tellurium	Total Thallium	Total Thorium	Total Tin	Total Titanium	Total Uranium
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
RR1	Provencher Bridge	34.1	0.215	< 0.0002	< 0.00002	< 0.0001	< 0.0002	0.021	0.0019
RR2	Between Disraeli and Redwood Bridges	43.4	0.232	< 0.0002	< 0.00002	0.0002	< 0.0002	0.022	0.002
RR3 top	Redwood Bridge	44.4	0.232	< 0.0002	< 0.00002	0.0002	< 0.0002	0.023	0.0021
RR3 bottom	Redwood Bridge	47.3	0.205	< 0.0002	< 0.00002	0.0002	< 0.0002	0.028	0.0021
RR5	End of plume downstream of Jefferson Outfall	51.5	0.235	< 0.0002	< 0.00002	< 0.0001	< 0.0002	0.022	0.002
RR6	West Shore near Marymound School	43.2	0.232	< 0.0002	< 0.00002	0.0001	< 0.0002	0.022	0.002
RR7	East Shore near Marymound School	49.5	0.23	< 0.0002	< 0.00002	0.0001	< 0.0002	0.019	0.002
RR4	North Perimeter Bridge	54	0.245	< 0.0002	< 0.00002	0.0001	< 0.0002	0.02	0.002
RR9	Downstream of Rivercrest	46.1	0.213	< 0.0002	< 0.00002	0.0001	< 0.0002	0.02	0.0021
RR10	Near Twin Oaks, Downstream from Scott House	47.3	0.212	< 0.0002	< 0.00002	< 0.0001	< 0.0002	0.014	0.0019
LD U/S	Upstream of Lockport Dam	43.1	0.208	< 0.0002	< 0.00002	< 0.0001	< 0.0002	0.013	0.0021
RR11	Downstream of Lockport Dam	42.2	0.205	< 0.0002	< 0.00002	0.0001	0.0005	0.016	0.0021
RR12	Selkirk Bridge	40.8	0.205	< 0.0002	< 0.00002	< 0.0001	< 0.0002	0.015	0.0022
RR13	Red River 3 km upstream of Lake Winnipeg	38.1	0.196	< 0.0002	< 0.00002	0.0002	< 0.0002	0.033	0.002

Table 21. Concentrations of trace metals at 14 stations on the Red River on September 20, 2002 (continued).

Station	Station Description	Total Vanadium	Total Zinc	Total Zirconium	Total Hexavalent Chromium	Mercury
		mg/L	mg/L	mg/L	mg/L	ug/L
RR1	Provencher Bridge	0.0051	0.007	< 0.002	< 0.02	0.03
RR2	Between Disraeli and Redwood Bridges	0.0055	0.011	< 0.002	< 0.02	0.03
RR3 top	Redwood Bridge	0.0056	0.01	< 0.002	< 0.02	0.04
RR3 bottom	Redwood Bridge	0.0061	0.01	< 0.002	< 0.02	0.04
RR5	End of plume downstream of Jefferson Outfall	0.0053	0.01	< 0.002	< 0.02	0.04
RR6	West Shore near Marymound School	0.0056	0.019	< 0.002	< 0.02	0.03
RR7	East Shore near Marymound School	0.0054	0.016	< 0.002	< 0.02	0.02
RR4	North Perimeter Bridge	0.0053	0.009	< 0.002	< 0.02	0.03
RR9	Downstream of Rivercrest	0.0054	0.008	< 0.002	< 0.02	0.04
RR10	Near Twin Oaks, Downstream from Scott House	0.0046	0.006	< 0.002	< 0.02	0.03
LD U/S	Upstream of Lockport Dam	0.0048	0.008	< 0.002	< 0.02	0.02
RR11	Downstream of Lockport Dam	0.0053	0.008	< 0.002	< 0.02	0.02
RR12	Selkirk Bridge	0.0051	0.005	< 0.002	< 0.02	0.02
RR13	Red River 3 km upstream of Lake Winnipeg	0.007	0.009	< 0.002	< 0.02	0.03

Table 22. Field measurements of dissolved oxygen (mg/L) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	8.12	7.74	7.30	7.60	7.40	7.80	7.90
RR2	Between Disraeli and Redwood Bridges	8.07	8.00	7.10	7.60	7.70	7.70	7.90
RR3 - top	Redwood Bridge	8.02	7.80	6.90	7.40	7.50	7.50	8.00
RR3 - bottom	Redwood Bridge	7.00	7.5	6.80	7.30	7.60	7.80	8.00
RR5	End of plume downstream of Jefferson Outfall		6.60	6.50	7.90	7.50	7.70	7.90
RR8	Within plume of Jefferson Outfall	7.50						7.80
RR6	West Shore near Marymound School	8.10	7.50	6.50	7.60	7.79	7.60	7.90
RR7	East Shore near Marymound School	7.40	7.90	7.10	7.90	8.10	7.70	7.90
RR4	North Perimeter Bridge	7.50	7.70	7.20	7.60	7.80	7.50	7.00
RR9	Downstream of Rivercrest	8.26	6.70	5.20	7.30	7.60	7.10	7.50
RR10	Near Twin Oaks, Downstream from Scott House		6.50	6.40	6.90	7.40	7.00	7.70
LD U/S	Upstream of Lockport Dam		8.10	7.10	6.60	7.70	7.05	7.50
RR11	Downstream of Lockport Dam		9.20	8.80	8.90	9.10	9.60	9.50
RR12	Selkirk Bridge	8.74	9.00	8.60	8.20	8.20	8.90	8.90
RR13	Red River 3 km upstream of Lake Winnipeg		8.70	8.30	8.80	9.00	8.30	8.70

Table 23. Field measurements of temperature (degrees C) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge	19.0	19.5	21.0	18.8	17.5	16.0	15.0
RR2	Between Disraeli and Redwood Bridges	19.0		19.2	18.7	17.0	16.0	15.0
RR3 - top	Redwood Bridge	19.0	19.5	19.2	18.8	17.3	16.0	15.0
RR3 - bottom	Redwood Bridge	20.0						
RR5	End of plume downstream of Jefferson Outfall		19.5	19.3	19.1	17.0	16.0	15.0
RR8	Within plume of Jefferson Outfall	19.0						
RR6	West Shore near Marymound School		19.0	19.6	18.3	17.0	16.0	15.0
RR7	East Shore near Marymound School	20.0	20.0	19.3	18.8	17.0	16.0	15.0
RR4	North Perimeter Bridge	18.5	20.0	19.4	18.7	17.3	16.0	15.0
RR9	Downstream of Rivercrest	20.0	20.0	19.3	18.0	17.0	16.4	15.0
RR10	Near Twin Oaks, Downstream from Scott House		20.0	19.4	18.7	17.5	16.1	15.5
LD U/S	Upstream of Lockport Dam		19.0	19.3	18.8	17.4	16.2	15.5
RR11	Downstream of Lockport Dam	20.0	19.0	19.4	18.0	17.0	16.5	15.5
RR12	Selkirk Bridge		19.0	19.4	18.6	17.0	16.5	16.0
RR13	Red River 3 km upstream of Lake Winnipeg		18.0	19.3	17.3	17	15	15

Table 24. Field measurements of conductivity (µS/cm) at 14 stations on the Red River.

Station	Station Description	17-Sep-02	18-Sep-02	19-Sep-02	20-Sep-02	21-Sep-02	22-Sep-02	23-Sep-02
RR1	Provencher Bridge		650	625	600	575	no meter	500
RR2	Between Disraeli and Redwood Bridges	663	675	650	675	600	no meter	525
RR3 - top	Redwood Bridge	650	675	600	450	600	no meter	550
RR3 - bottom	Redwood Bridge		675				no meter	
RR5	End of plume downstream of Jefferson Outfall			700	675	600	no meter	550
RR8	Within plume of Jefferson Outfall	650					no meter	
RR6	West Shore near Marymound School		650	700	700	600	no meter	550
RR7	East Shore near Marymound School	650	650	700	700	600	no meter	550
RR4	North Perimeter Bridge	650	625	700	700	600	no meter	550
RR9	Downstream of Rivercrest	610	625	700	650	600	no meter	575
RR10	Near Twin Oaks, Downstream from Scott House		600	650	675	650	no meter	575
LD U/S	Upstream of Lockport Dam		610	650	700	no meter	no meter	600
RR11	Downstream of Lockport Dam		600	650	675	no meter	no meter	575
RR12	Selkirk Bridge	600		650	675	no meter	no meter	575
RR13	Red River 3 km upstream of Lake Winnipeg		400	600	600	no meter	no meter	575

Table 25. Field measurements of conductivity and dissolved oxygen near several effluent outfalls.

Station	Date	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)
Selkirk Avenue Outfall			
1.5 metres from outfall	17-Sep-02	950	1.0 to 3.0
Edge of plume from outfall	17-Sep-02		7.8
1.5 meters from outfall	19-Sep-02		7.0
1.5 meters from outfall	20-Sep-02		7.3
1.5 meters from outfall	22-Sep-02		7.6
Outfall near West Kildonan Park			
6 metres from outfall	17-Sep-02	900	2.5 to 3.0
15 metres from outfall	17-Sep-02	675	7.0
1.5 meters from outfall	19-Sep-02		7.0
1.5 meters from outfall	20-Sep-02		7.2
1.5 meters from outfall	22-Sep-02		7.6
Jefferson Avenue Outfall			
1.5 metres from outfall	17-Sep-02		0.1
1.5 metres from outfall	18-Sep-02		0.5
1.5 metres from outfall	19-Sep-02		7
1.5 metres from outfall	22-Sep-02		6.8

Table 26. *Escherichia coli* densities (Colony forming units per 100 mL) at 10 beaches on Lake Winnipeg.

Station	Date	*Escherichia coli* densities (Colony forming units per 100 mL)
Victoria Beach (Clubhouse Area) (MB05SAS012)		
	18-Sep-02	25
	20-Sep-02	32
	23-Sep-02	10
	26-Sep-02	11
Victoria Beach (Red Cross Dock) (MB05SAS013)		
	18-Sep-02	10
	20-Sep-02	N/A
	23-Sep-02	10
	26-Sep-02	20
Lester Beach (MB05SAS014)		
	18-Sep-02	10
	20-Sep-02	10
	23-Sep-02	11
	26-Sep-02	12
East Grand Beach (MB05SAS015)		
	18-Sep-02	10
	20-Sep-02	48
	23-Sep-02	10
	26-Sep-02	11
West Grand Beach (MB05SAS016)		
	18-Sep-02	53
	20-Sep-02	11
	23-Sep-02	19
	26-Sep-02	16
Patricia Beach (MB05SAS017)		
	18-Sep-02	113
	20-Sep-02	179
	23-Sep-02	55
	26-Sep-02	39
Gimli Beach (MB05SBS012)		
	18-Sep-02	174
	20-Sep-02	503
	23-Sep-02	231
	26-Sep-02	93
Sandy Hook Beach (MB05SBS023)		
	18-Sep-02	26
	20-Sep-02	17
	23-Sep-02	14
	26-Sep-02	10
Winnipeg Beach (MB05SBS024)		
	18-Sep-02	62
	20-Sep-02	26
	23-Sep-02	287
	26-Sep-02	23
Matlock Beach (Ralph Avenue) (MB05SBS025)		
	18-Sep-02	21
	20-Sep-02	148
	23-Sep-02	130
	26-Sep-02	82

Table 27. Differences in macroinvertebrate densities among sampling locations as shown by one way analysis of variance ($p \leq 0.05$).

	Jefferson Avenue Outfall (RR8)	Jefferson Avenue Reference (RR8E)	Kildonan Park Outfall (RR14)	Kildonan Park Reference (RR14E)	Selkirk Post-Overflow (RR12)	Selkirk Pre-Overflow (OJS074)	Red River Near Lake Winnipeg (RR13)
Jefferson Avenue Outfall (RR8)							
Jefferson Avenue Reference (RR8E)	Different (p=0.0010)						
Kildonan Park Outfall (RR14)	Not Different	Different (p=0.0008)					
Kildonan Park Reference (RR14E)	Different (p=0.0039)	Not Different	Different (p=0.0032)				
Selkirk Post-Overflow (RR12)	Not Different	Different (p=0.0021)	Not Different	Different (p=0.0097)			
Selkirk Pre-Overflow (OJS074)	Not Different	Different (p=0.0018)	Not Different	Different (p=0.0086)	Not Different		
Red River Near Lake Winnipeg (RR13)	Different (p=0.0014)	Not Different	Different (p=0.0011)	Different (p=0.0021)	Different (p=0.0025)	Different (p=0.0021)	

Table 28. Macroinvertebrate densities at seven stations on the Red River.

Class	Order	Family	Genus	species	Date	25-Sep	25-Sep	25-Sep	25-Sep	25-Sep	25-Sep	25-Sep	25-Sep	25-Sep	25-Sep	24-Sep	24-Sep	24-Sep
					Site	RR12	RR12	RR12	RR12	RR12	RR13	RR13	RR13	RR13	RR13	RR14	RR14	RR14
					Rep	1	2	3	4	5	1	2	3	4	5	1	2	3
ANNELIDA	OLIGOCHAETA	ENCHYTRAEIDAE	*Lumbricillus*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	153.1	0.0	19.1
ANNELIDA	OLIGOCHAETA	TIBIFICIDAE	*Branchiura*	*sowerbyi*		19.1	19.1	38.3	0.0	0.0	0.0	0.0	0.0	0.0	191.4	0.0	0.0	0.0
ANNELIDA	OLIGOCHAETA	TUBIFICIDAE	*Limnodrilus*	*sp.*		19.1	401.8	459.2	114.8	0.0	0.0	0.0	133.9	229.6	669.7	0.0	229.6	325.3
ANNELIDA	OLIGOCHAETA	TUBIFICIDAE	*Tubifex*	*sp.*		0.0	19.1	19.1	0.0	0.0	0.0	0.0	0.0	57.4	38.3	0.0	0.0	0.0
GASTROPODA	CTENOBRANCHIATA	HYDROBIIDAE	*Amnicola*	*limosa*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSECTA	DIPTERA	CERATOPOGONIDAE	*Palpomyia*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.1	38.3	19.1	0.0	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Ablabesmyia*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	191.4	153.1	0.0	0.0	19.1	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Chironomus*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.1	0.0	0.0	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Clinotanypus*	*sp.*		0.0	19.1	0.0	0.0	0.0	0.0	0.0	210.5	153.1	19.1	0.0	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Cryptochironomus*	*sp.*		0.0	0.0	0.0	0.0	0.0	57.4	0.0	0.0	19.1	38.3	0.0	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Cryptotendipes*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Paralauterborniella*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Paracladopelma*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Polypedilum*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.1	19.1
INSECTA	DIPTERA	CHIRONOMIDAE	*Procladius*	*sp.*		0.0	57.4	0.0	19.1	19.1	38.3	0.0	95.7	267.9	229.6	0.0	19.1	0.0
INSECTA	EPHEMEROPTERA	EPHEMERIDAE	*Hexagenia*	*limbata*		0.0	0.0	0.0	0.0	19.1	0.0	19.1	497.5	803.7	153.1	0.0	0.0	0.0
INSECTA	EPHEMEROPTERA	EPHEMERIDAE	*Hexagenia*	*rigida*		0.0	0.0	0.0	19.1	0.0	0.0	38.3	669.7	459.2	38.3	0.0	0.0	0.0
INSECTA	EPHEMEROPTERA	EPHEMERIDAE	*Ephemera*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSECTA	TRICHOPTERA	HYDOPSYCHIDAE	*Cheumatopsyche*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSECTA	TRICHOPTERA	HYDROPSYCHIDAE	*Potamyia*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSECTA	TRICHOPTERA	LEPTOCERIDAE	*Oecetis*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.1	19.1	19.1	0.0	0.0	0.0
PELECYPODA	SPHAERIACEA	SPHAERIDAE	*Sphaerium*	*sp.*		0.0	19.1	19.1	19.1	57.4	76.5	0.0	38.3	95.7	19.1	0.0	0.0	0.0

Table 28. Macroinvertebrate densities at seven stations on the Red River (continued).

Class	Order	Family	Genus	species	Date	24-Sep	24-Sep	24-Sep	24-Sep	24-Sep	24-Sep	24-Sep	24-Sep	24-Sep	28-Aug	28-Aug	28-Aug	28-Aug	28-Aug
					2002 Site	RR14E	RR14E	RR14E	RR8	RR8	RR8	RR8E	RR8E	RR8E	OJS074	OJS074	OJS074	OJS074	OJS074
					Rep	1	2	3	1	2	3	1	2	3	6D	7D	8D	9D	10D
ANNELIDA	OLIGOCHAETA	ENCHYTRAEIDAE	*Lumbricillus*	*sp.*		0.0	0.0	0.0	0.0	38.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ANNELIDA	OLIGOCHAETA	TIBIFICIDAE	*Branchiura*	*sowerbyi*		19.1	0.0	0.0	19.1	0.0	0.0	0.0	19.1	0.0	0.0	0.0	0.0	0.0	0.0
ANNELIDA	OLIGOCHAETA	TUBIFICIDAE	*Limnodrilus*	*sp.*		497.5	287.0	1760.4	421.0	401.8	401.8	0.0	306.2	210.5	0.0	401.8	95.7	0.0	210.5
ANNELIDA	OLIGOCHAETA	TUBIFICIDAE	*Tubifex*	*sp.*		0.0	0.0	0.0	0.0	0.0	19.1	0.0	57.4	19.1	0.0	0.0	0.0	0.0	0.0
GASTROPODA	CTENOBRANCHIATA	HYDROBIIDAE	*Amnicola*	*limosa*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.1
INSECTA	DIPTERA	CERATOPOGONIDAE	*Palpomyia*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.1	19.1	0.0	0.0	0.0	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Ablabesmyia*	*sp.*		19.1	19.1	19.1	0.0	0.0	0.0	0.0	76.5	38.3	0.0	19.1	0.0	19.1	133.9
INSECTA	DIPTERA	CHIRONOMIDAE	*Chironomus*	*sp.*		19.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.1	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Clinotanypus*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Cryptochironomus*	*sp.*		57.4	191.4	287.0	0.0	0.0	0.0	0.0	153.1	153.1	0.0	19.1	0.0	0.0	57.4
INSECTA	DIPTERA	CHIRONOMIDAE	*Cryptotendipes*	*sp.*		0.0	38.3	0.0	0.0	0.0	0.0	0.0	57.4	0.0	0.0	0.0	0.0	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Paralauterborniella*	*sp.*		38.3	0.0	0.0	0.0	0.0	0.0	0.0	38.3	19.1	0.0	0.0	0.0	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Paracladopelma*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.3	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Polypedilum*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.3	95.7	0.0	0.0	0.0	0.0	0.0
INSECTA	DIPTERA	CHIRONOMIDAE	*Procladius*	*sp.*		114.8	57.4	95.7	0.0	0.0	0.0	0.0	382.7	229.6	0.0	0.0	0.0	0.0	19.1
INSECTA	EPHEMEROPTERA	EPHEMERIDAE	*Hexagenia*	*limbata*		57.4	19.1	0.0	0.0	0.0	0.0	57.4	229.6	287.0	153.1	0.0	0.0	0.0	172.2
INSECTA	EPHEMEROPTERA	EPHEMERIDAE	*Hexagenia*	*rigida*		19.1	19.1	0.0	0.0	0.0	0.0	0.0	38.3	172.2	19.1	0.0	0.0	0.0	0.0
INSECTA	EPHEMEROPTERA	EPHEMERIDAE	*Ephemera*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.0	0.0	0.0	0.0	0.0
INSECTA	TRICHOPTERA	HYDOPSYCHIDAE	*Cheumatopsyche*	*sp.*		19.1	0.0	0.0	0.0	19.1	19.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSECTA	TRICHOPTERA	HYDROPSYCHIDAE	*Potamyia*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	95.7	19.1
INSECTA	TRICHOPTERA	LEPTOCERIDAE	*Oecetis*	*sp.*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PELECYPODA	SPHAERIACEA	SPHAERIDAE	*Sphaerium*	*sp.*		38.3	0.0	0.0	0.0	0.0	0.0	38.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0